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Mapping health outcomes from ecosystem services

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7.6. Mapping health outcomes from ecosystem services

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Introduction

The practice of mapping ecosystem services (ES) in relation to health outcomes is only in its early developing phases. Air purification by vegetation and the resulting avoided respiratory disease burden is a health-related ES that is currently mapped for several areas in the world (see Figure 1 for an example in the United States). Another example is the attenuation of ocean waves by marine ecosystems and the subsequent reduction in population at risk from flooding. The latter is a health proxy as no connections are made to drowning. Of course, the value of other ES is approximated through maps as well, but map values are often biophysical rather than human health related. Table 1 lists several examples.

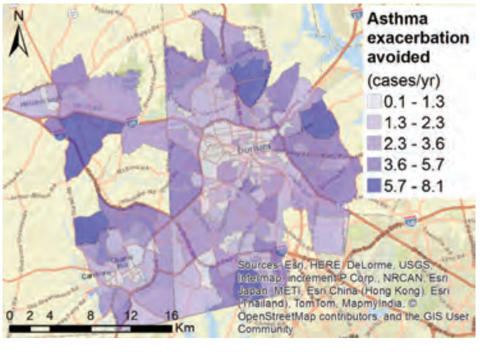

Figure 1. Estimations of the annual number of asthma exacerbation cases that may be avoided due to total nitrogen dioxide removed by trees per census block group. (Shown here is Durham, North Carolina.) Adopted from EPA's "EnviroAtlas Interactive Map".

ES - health mapping challenges

When combining information about human health with information about ecological systems - and with social complexity which is part of social ecological and environmental health systems - we not only combine complex information which is different in nature, but we also combine scientific cultures containing a diversity of methodological approaches, data and evidence. We also need to make choices: we can never fully grasp nor take into account all potentially relevant complexity. This is not only just a matter of choice, it also has important consequences for the quality of our outputs. Especially regarding the links between nature and human health, "the devil is in the detail": we need to take into account specific characteristics of nature and target groups whose health is affected. Here we introduce some specific challenges.

First, ES supply and demand often relate to different spatial locations (Chapter 5.2). This is specifically relevant to health-related ES as they often benefit from close to the supply source. Due to the spatial explicitness of supply and demand, mapping is also a proper solution for this challenge. High resolution data are needed on, amongst others, the location of vegetation and the location of exposed people (e.g. places with a high population density). We also need to take into account different effects for differences in vulnerability of different groups.

Table 1. Examples of direct health-related ES that are currently mapped and provide promising starting points to assess health impacts

Mapped ecosystem service	Example indicator used	Prevented health outcomes
Air purification	Air pollutant uptake (mass per area unit per year)	Respiratory diseases, cardiovascular diseases, cancer
Flood protection	Reduced wave height, shoreline erosion	Drowning, infectious diseases, mental disorders, respiratory diseases
Biological control of infectious diseases	Habitat suitability (index / categorical values, habitat presence likelihood)	Infectious and parasitic diseases
Noise reduction	Reduced noise intensity (per area unit)	Hearing loss, cardiovascular diseases
Cooling	Temperature reduction (per area unit)	Heat stroke, heat exhaustion, mental disorders
Recreation / provision of aesthetic values	Index value, relative value, monetary value, number of visits (per area unit)	Mental and behavioural disorders, cardiovascular diseases, obesity
Medicinal plants and other medicinal resources	Availability, associated traditional knowledge, threat status, volume of trade market value and non-monetary value	Several conditions depending on species and associated knowledge

The second challenge is that health-related ES are often buffered or enhanced by socio-economic factors. In the case of flood protection, the effect of flooding on human casualties depends strongly on flood response programmes and man-made structures to prevent flooding. A third challenge is the presence of health-related ecosystem disservices which are perceived as harmful, unpleasant or unwanted. In several cases, these originate in the same ecosystem types and affect the same health outcomes as their ES counterparts, but increase health burden. Examples of the latter are emissions of VOC (Volatile Organic Compounds), allergens and locally increasing air pollution concentrations and the potentially dual role of biodiversity in relation to infectious diseases.

Several other challenges of mapping health-related ES are more ES-specific. For recreation, quantitative epidemiological exposure-response models are needed to link to health outcomes such as a reduction in depression. ES supply also depends on the ecosystem structure at micro scale such as vegetation type, height and density; dense shrubbery is effective for lowering noise levels, while clean and cool air is mainly provided by trees. Most ES maps do not yet incorporate such spatial and thematic detail. Figure 2 shows a map which was built using high resolution spatial data that differentiate several vegetation types. The result is that the bundle of ES provided can differ substantially for districts within the same city, even when they are equal in terms of the surface area occupied by vegetation and water. Thus, to be able to map ES that moderate environmental risks to health on a city scale, detailed data of ecosystem types are needed.

ES - health mapping design options

Health indicators are necessary to make health outcomes spatially explicit and to assess health impacts. The choice of indi-

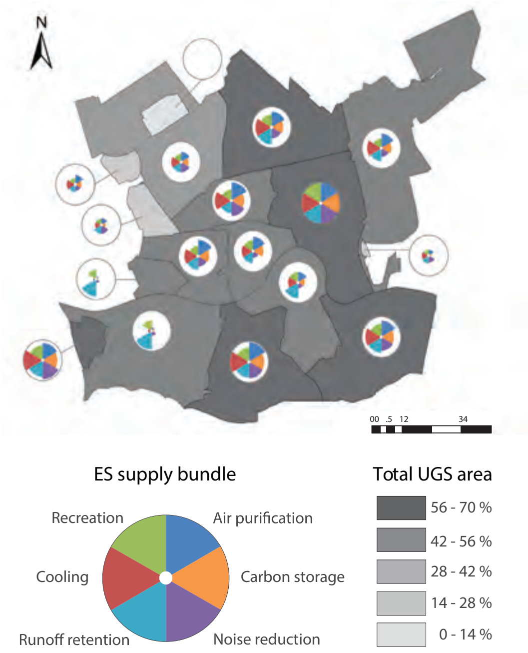

Figure 2. Supply of ES bundles, aggregated to district level in Rotterdam, The Netherlands. Background colours depict total urban green and blue space (UGS) area.

cators and metrics depends on the specific research objective: if focussed on a single ES-related health outcome, then one specific indicator can be used. Maps could then display avoided cases of a specific disease (per area unit per year), avoided infectious disease outbreaks or areas where a health threshold value is exceeded (e.g. drinking water quality or noise intensity threshold). However, if the objective is more integrative, for example, to calculate a region's total (avoided) health burden or to assess an area's net health effect (positive or negative), then an aggregate health indicator or common metric would give more useful insights. Such metrics to express the health effect of several health-related ES in a common unit are for example mortality, life expectancy, the disability adjusted life year (DALY), a monetary value (such as avoided costs of hospital visits) or the number of affected people. Each comes with its own advantages and disadvantages. For example, mortality as an indicator would not include the effects of several non-lethal diseases and conditions with severe effects on well-being, whereas DALYs make use of disability weight factors (reflecting the severity of the disease) which are often difficult to estimate. Additionally, some argue that such integrative health indicators still fail to capture the full breadth of the complex linkages between biodiversity and health (including social determinants and cultural underpinnings) and that therefore a more holistic approach is necessary.

Complexity often means making difficult methodological choices on what we need to take into account (and how). Hence, we also need to critically think about the process of methodological decision-making: who is involved in making those choices and whose knowledge, information and viewpoints are taken into account? In Western expert culture, expert-driven mapping is still dominant. Mapping can also relate to processes that facilitate assessment of natural and human resources contributing to health and further strengthening them. The next section exemplifies alternative approaches that include traditional local knowledge and participatory bottom-up mapping techniques relevant to health. The focus is on participatory assessment methods and tools that identify healthcare delivery issues amongst local communities and how these may be alleviated with resources from the proximate ecosystems.

Participatory ES - health mapping

The significance of ecosystem specific plants and other resources and related local traditional knowledge is much more profound for the health and nutritional security of people in marginalised regions of the world in addition to their cultural relevance. Identifying local health priorities and supplementing them with ecosystem and community-specific traditional medical knowledge and resources through primary health programmes, is critical both to ensure conservation of biodiversity and health security at the local level. Important dimensions of participatory mapping and prioritisation of healthcare issues at the level of local communities are: 1) ranking of health challenges in a local community/region; 2) discourse-based mapping of traditional knowledge-based remedies for prioritised health challenges; 3) cataloguing medicinal biological resources and their availability in local communities; 4) mapping various other resources such as human-, sociocultural- and economic-produced resources.

In India, such rapid validation methodology is applied for determining effective community-based traditional medical knowledge practices. This is a rapid assessment as it involves no detailed laboratory or clinical studies on the efficacy of selected practices but depends on secondary literature reviews of revealed practices. Following an exhaustive documentation and prioritisation of health conditions, data obtained on local medicinal plant resources and associated knowledge in relation to the selected health conditions are matched. Subsequently, a detailed compilation of the global data on safety and efficacy of the selected remedy is done from various phytochemical, pharmacological and clinical literature. It also includes collecting exhaustive data from codified traditional medical systems of the region. Once the dossier has been prepared, a participatory assessment is conducted in the respective communities with involvement of various disciplinary experts. Each practice is discussed in detail, based primarily on a community's historical experience of the traditional knowledge practice as well as the secondary literature on their safety and efficacy. These are made into comprehensive user manuals that are used to build the capacities of village health workers to popularise the practices. Shortlisted plants are grown in nursery networks to be supplied for establishing home as well as community health gardens.

Often participatory clinical cohort studies are conducted to examine efficacy of the selected practices from such local pharmacopeia. Several such participatory mapping and assessment of traditional knowledge programmes have been conducted across India and selected locations in Asia and Africa since 2008. For example, to tackle the onset of malarial infection, community mapping of traditional knowledge practices has been performed in endemic regions in India. Applying the above documentation and participatory rapid assessment methodology, several location-specific prophylactic malaria remedies were selected for cohort clinical studies in order to explore their efficacy. The programme has demonstrated that significant health improvements are possible through community level intervention using local resources and associated knowledge.

Further information

Interactive maps of health outcomes or health proxies:
EPA, Enviroatlas Interactive Map:
http://www2.epa.gov/enviroatlas/enviroatlas-interactive-map
Coastal Resilience mapping portal:
http://maps.coastalresilience.org/network/

Further reading

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